

Wisconsin Forest Tree Improvement Program 2004 Annual Report



Prepared by

Gregory Edge, Forest Geneticist and Nursery Specialist,
WDNR, Division of Forestry and
David Stevens, Tree Improvement Specialist, Forest Ecology and Management,
University of Wisconsin-Madison and
Raymond P. Guries, Professor, Forest Ecology and Management,
University of Wisconsin-Madison

Wisconsin Forest Tree Improvement Program Contact Information:

Wisconsin Department of Natural Resources

Gregory Edge, Forest Geneticist and Nursery Specialist
Wisconsin Department of Natural Resources
3550 Mormon Coulee Road
La Crosse, WI 54601
Email: Gregory.Edge@dnr.state.wi.us
Phone: (608) 785-9011

Kristin Peterson, Tree Improvement Program Assistant
Wisconsin Department of Natural Resources
P.O. Box 7921
Madison, WI 53707
Email: Kristin.Peterson@dnr.state.wi.us
Phone: (608) 264-6044

University of Wisconsin – Madison

Raymond P. Guries, Professor
Forest Ecology and Management, University of Wisconsin – Madison
1630 Linden Drive
Madison, WI 53706
Email: RPGURIES@wisc.edu
Phone: (608) 262-0449

David Stevens, Tree Improvement Specialist
Forest Ecology and Management, University of Wisconsin – Madison
1630 Linden Drive
Madison, WI 53706
Email: DSTEVENS@wisc.edu
Phone: (608) 263-6977

Introduction

The Wisconsin Department of Natural Resources' (WDNR) forest nursery program produced and distributed 17.6 million tree seedlings in 2004, reforesting almost 20,000 acres of public and private lands in Wisconsin. The use of genetically improved seed remains a critical part of this annual reforestation effort, ensuring that WDNR seedlings are well-adapted to Wisconsin growing conditions and have a high potential for survival and growth. The Wisconsin tree improvement program, through the long-term support of the state nurseries, continues to develop and manage seed orchards using a combination of parent tree and family selection, progeny testing and selective breeding. First generation seed orchards are currently established for white pine, jack pine, red pine, white spruce, red oak and black walnut. Second-generation seed orchards are established for jack pine.

Seed orchards are the primary mechanism used to produce genetically improved seed in quantities large enough to support nursery production. We continue to expand and develop our seed orchards for white pine, jack pine, red pine, white spruce, red oak, and black walnut (Table 1). Priorities for 2004 included completing controlled pollinations within four populations of advanced generation jack pine, selection of superior parent trees based on height, diameter, and form for establishment of second generation red pine seed orchards, and development of grafted or clonal populations of white spruce, black walnut, and red oak. Our work continues to emphasize critical maintenance and intensive management of seed orchards to facilitate the production of greater quantities of improved seed. This includes research on improved seed production and collection techniques for traditionally challenging species such as red pine.

Table 1. WDNR seed orchard acreage by species.

Species	Acreage
Jack Pine	20
Red Pine	45
White Pine	52
White Spruce	34
Black Walnut	13
Red Oak	9

This report highlights the 2004 program activities and accomplishments for our primary tree improvement species. Please feel free to contact the report's authors if you have any questions or comments.

2004 Program Highlights

Jack Pine

Selection and breeding for a third generation continued in four populations of jack pine growing at the Ten Mile Creek Seed Orchard (Wood Co.). Height measurements from the fall of 2001, in conjunction with scores for incidence of pine-oak gall rust, *Cronartium quercum*, were used to select superior trees for breeding using a polycross mating scheme to produce progeny for third generation populations. A total of 272 controlled pollinations were completed in the spring of 2004, focusing on trees that didn't produce flowers for crosses in 2003. Eighty eight single-pair crosses among the best trees in elite families were also made to use in developing production seed orchards. Early conelet counts indicate that all but one family had at least one successful cross. The overall success rate, however, was lower than previous years due to the abnormally wet, cold spring. The 2003 controlled crosses were harvested in September 2004; these crosses produced 411 cones. Seeds will be extracted from these cones during the winter. Controlled pollinations will continue during the 2005 season, hopefully completing third generation breeding efforts within the four Ten Mile Creek 'index' populations. Potential planting sites for the third generation index population are being evaluated in central Wisconsin. Selection and breeding will also begin at the Ladysmith (Rusk County) 2nd generation breeding population that is currently managed by Plum Creek Timber Company.



U.W.-Madison Forestry 101 student bud capping crew with David Stevens at the Black River Falls white pine orchard.

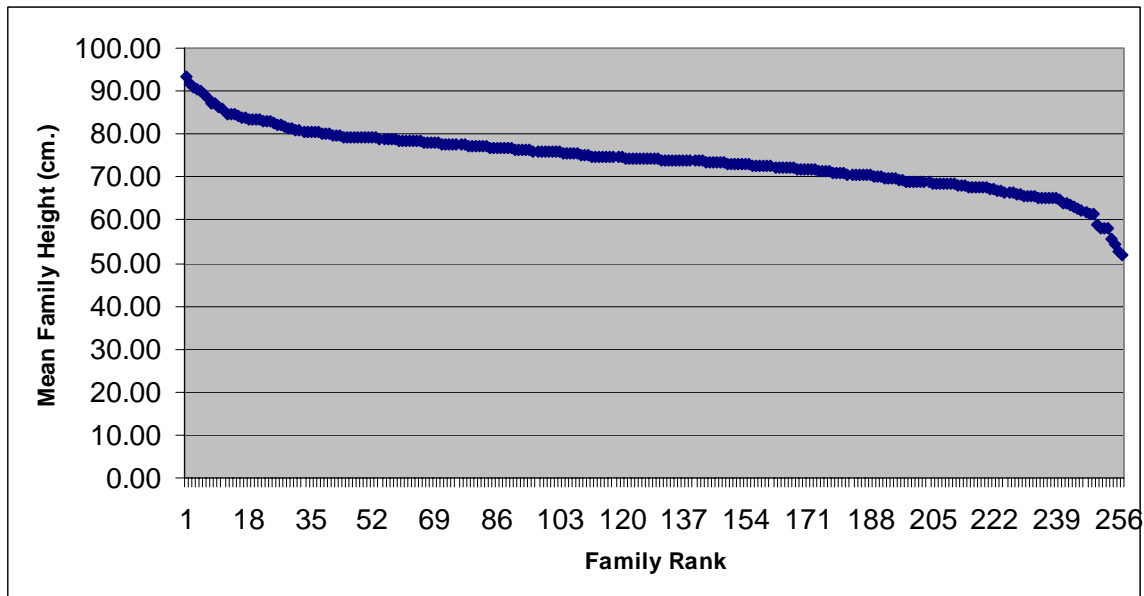
Eastern White Pine

Information on the extent and patterning of genetic variation in Wisconsin's eastern white pine populations will be obtained from the two provenance/family

tests established during 2002-2003. These tests also will provide a source of improved seed for the state nurseries following genetic evaluation. Cones from 234 trees representing 50 natural stands of eastern white pine were collected across Wisconsin during 1996-2000. In addition, Dr. Richard Meier (USDA-Forest Service, R-9) provided seed from 142 USDA-Forest Service selections made in the Upper Peninsula of Michigan, Minnesota and Wisconsin. The first orchard was field planted in 2002 on a 14-acre site near Lake Tomahawk in the Northern Highland-American Legion State Forest to create a “northern” Wisconsin test. A “southern” Wisconsin orchard was field planted in 2003 on the Black River State Forest.

Both family tests were measured for height and survival during the fall of 2004. Mean family heights vary by as much as 55% between families after three years at the Lake Tomahawk planting (Table 2) and 58% after two years at the Black River Falls planting.

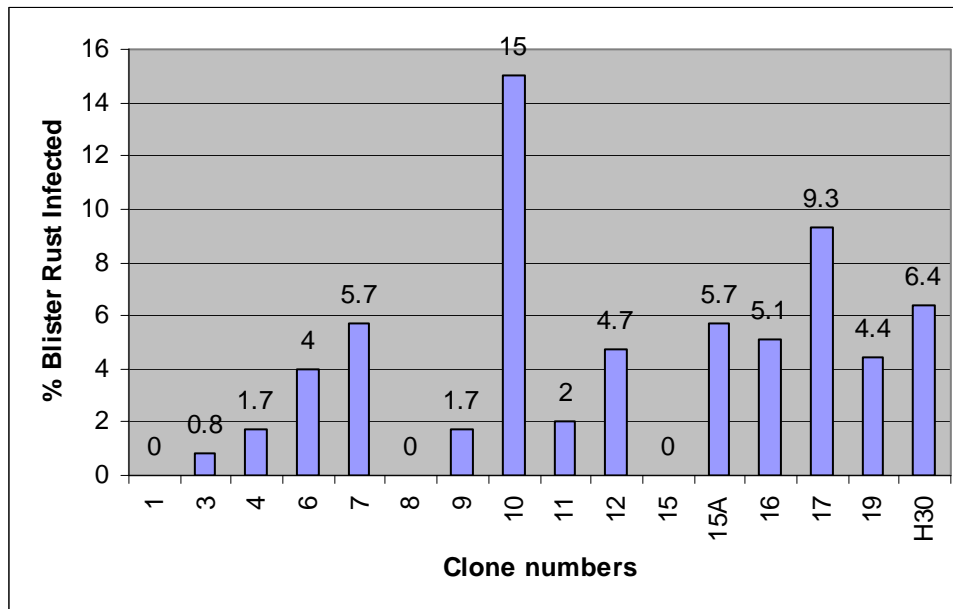
Table 2. Mean family height after 3 growing seasons in the field at the Lake Tomahawk white pine orchard.



A late summer drought in 2003 caused considerable moisture stress for the Black River Falls planting, and approximately 6% of the trees (461 trees) were lost. The pattern of mortality observed indicates that location within the planting site had the greatest effect on survival, while genetics had little effect. The mortality rate at Lake Tomahawk in contrast is 1% (117 trees). Both plantings were maintained through the growing season by mowing, cultivating and herbicide application. Bud caps were attached to all trees in the late fall to discourage deer browsing. The short-term benefit of this research will be the identification of eastern white pine seed sources appropriate for use in reforestation efforts; the long-term benefits will be the development of two seedling seed orchards for future seed production and genetic resource conservation of Lake States white pine.

Beginning in 1983, through a cooperative effort with the USDA-Forest Service, grafts of putative blister rust-resistant eastern white pine were obtained and planted within a ten-acre clonal seed orchard at the Sawyer Creek Fishery Area (Washburn County). Between 1994 and 2003, open pollinated progeny from these clones were planted in nearby fields and monitored for height growth and blister rust incidence by Mr. Shane Weber, WDNR Northern Region forest entomologist. Early test results indicate that clone #10 performed significantly worse than all other clones (Table 3) and it will be removed from the seed orchard. Over the next few years, we will be grafting and adding new clones to the orchard using materials derived from a new rust screening program the Forest Service is implementing at the Oconto River Seed Orchard.

Table 3. 2003 white pine blister rust incidence at the Sawyer Creek progeny test.



Red Pine

Three 15-acre seedling seed orchards consisting of 310 families from native Wisconsin stands were established in 1970 at Avoca (Iowa Co.), Lake Tomahawk (Oneida Co.) and Ten Mile Creek (Wood Co.). These seed orchards have been thinned twice using height data to retain the tallest and best-formed trees and families.

The 'best' individuals from within the tallest 125 families at each orchard were identified during 2003-04 using diameter measurements (in lieu of height – the trees are now 50-60 feet tall) and form ratings. All the identified trees at the Ten Mile Creek and Lake Tomahawk sites were surveyed for cones, and open-pollinated seed was subsequently collected from 175 of the trees. Seed will be collected from the remaining selections in 2005-2006 and used to establish progeny tests and a second generation seed orchard.

The Ten Mile Creek orchard was commercially thinned in 2003 to improve crown development for increased seed production and to facilitate seed

collection efforts. The Avoca and Lake Tomahawk orchards have been marked for a thinning and should be commercially thinned in 2005-2006.

White Spruce

White spruce tree improvement efforts continue to focus on the intensive management of seed orchards and progeny tests in order to supply improved seed for all state nursery production. State funding was also secured to build an improved greenhouse and propagation facility at the WDNR South Central Regional Headquarters in Fitchburg. This facility will greatly improve our ability to develop second generation grafted/clonal seed orchards. Greenhouse plans will be developed this winter and construction should begin in 2005 or 2006.

Seventeen-year height and diameter measurements for the Sawyer Creek progeny test (Washburn Co.), a 10-acre plantation established in 1989, were taken in 2003 and analyzed and ranked according to tree volume. This test contains selected materials from 168 different families from throughout the Lake States region and the Ottawa Valley. Superior parents identified in this analysis will be incorporated into the grafting program to expand clonal seed orchards.

The 6-acre Lake Tomahawk seedling seed orchard established in 1969 in the Northern Highland-American Legion State Forest was mowed to remove a dense under story of woody vegetation. The top 66% of individuals were color-coded based on a combined selection index for volume to facilitate future cone collection from the best trees. The orchard consists of 92 families selected by the USDA-Forest Service from the Lake States and Ottawa Valley, Ontario.

The 6-acre Mead Wildlife Area (Marathon County) seedling seed orchard had the shortest 30% of its population marked for thinning based on 1997 height data. This will allow greater access into the orchard for future cone harvests, as well as improve crown development. The orchard is comprised of 175 families representing materials from Ottawa Valley, Ontario, and selections from the Lake States region made by the USDA-Forest Service.

Black Walnut

Black Walnut remains a species of great importance to landowners and the forest products industry in southern Wisconsin. To date, our efforts have focused on selecting superior quality trees in natural stands and grafting scions from those trees into clonal seed orchards. Scion wood was collected during the winter from 3 trees in Grant County, and a total of 52 grafts were completed at the U.W.-Madison Walnut Street greenhouses. We hope to improve our future grafting success rate by incorporating new black walnut grafting techniques being used by the Hardwood Tree Improvement and Regeneration Center at Purdue University. Greg Edge and David Stevens will travel to the center in spring 2005 to attend a grafting workshop.

In order to accelerate the conservation and genetic improvement of black walnut, a pilot project was initiated to identify 20-30 potential "seed production

areas” within natural stands in southern Wisconsin. Seed production areas are natural stands of high quality trees that are managed for seed collection purposes. Seed production areas could provide an immediate supply of high quality seed to the state nurseries. In addition, progeny testing of these sources, along with culling of poor individuals and stands, would provide a modest level of genetic improvement. Since most of the seed production areas will likely be located on private land, the key to success will be cooperation with private landowners. Incentives, such as increased seed prices, will be needed to encourage involvement. Partnerships with groups, such as the Wisconsin Walnut Council (WWC), will also be critical. Through a successful partnership effort in 2004, the WWC harvested and the Wisconsin State Nursery seeded 150 bushels of cleaned walnut seed from a high quality stand in Rock County.

Red Oak

Following a strategy similar to black walnut, northern red oak scion wood was collected during the winter from 6 superior quality trees growing in natural stands in Eau Claire County. A total of 132 grafts were completed at the U.W.-Madison Walnut Street greenhouses, where they were subsequently grown for the remainder of the year. These grafted trees will eventually be planted into a clonal seed orchard at Bell Center for use by the state nursery system.

Future efforts with red oak also will include the identification and development of seed production areas. Red oak acorn crops often vary by year and location. For example, the 2004 red oak acorn crop was poor throughout most of the state, except for a few counties in north central Wisconsin. A network of seed production areas will provide an immediate and reliable source of quality native seed in several areas across the state, improving the consistency and diversity of the state nursery acorn supply.

Reforestation Issues

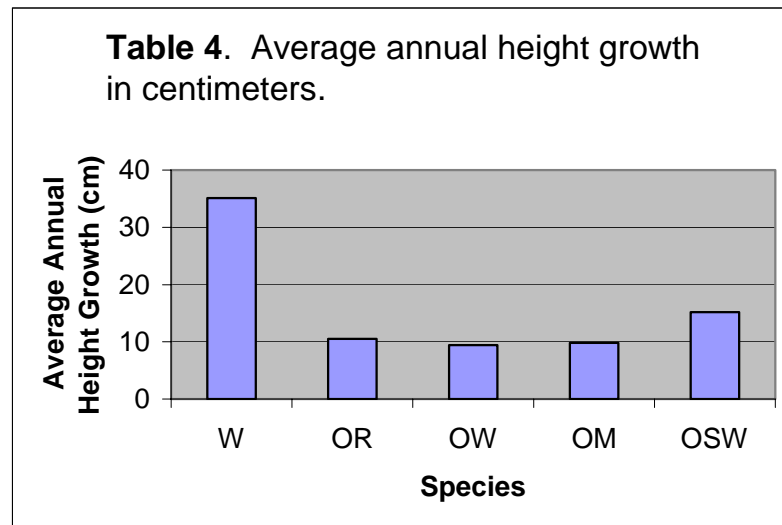
Hardwood Direct Seeding Survey

Hardwood direct seeding has grown in popularity across the Lake States. In 2004, we completed a survey of 31 direct-seeded hardwood plantings in Grant, Richland, Iowa, Lafayette, Sauk, and Manitowoc counties to learn more about the successes and failures of this reforestation method. The tree species sown included black walnut, northern red oak, white oak, bur oak, swamp white oak, sugar maple, and shagbark hickory. All the plantings were high-density sowings on former agricultural fields, with density goals ranging from 3000 to 8000 stems per acre. Most sites were planted using a hardwood seeder or drill. Occasionally, supplemental hand planting was used to introduce a light-seeded species that could not be run through the seeder, such as sugar maple. Twenty-nine sites were fall planted and two were spring planted.

These direct seeded plantations, with stand densities of 650 to 18,000 stems per acre, were more variable in stocking than traditional plantations established with seedlings. Not all species germinated well, leading to under- and over-stocked stands. Black walnut had the most consistent stocking levels, with germination rates of 60-70%. Direct seeding with black walnut appeared quite

successful at most sites. Red oak stocking was more variable, with germination rates of 3-100%, and averaging 30-40%. The white oak group had the poorest stocking, with germination rates of 0-90%, and averaging 10-20%.

Important differences were also noted in the juvenile height growth of direct-seeded plantations (Table 4). Black walnut had by far the greatest seedling height growth, averaging 35 centimeters (14 inches) per year. Red oak averaged just 11 centimeters (4 inches) per year and the other oak species were similar. This large difference in juvenile height growth resulted in problems for mixed oak and walnut plantations. The black walnut quickly established dominance, suppressing all oak seedlings. *For a complete copy of the survey results, please contact Greg Edge.*



Seedling Temperature Data Loggers

Experienced tree planters know the importance of keeping bare root seedlings cool prior to planting. Storage temperatures above 50° F can permanently damage seedlings and they are particularly vulnerable to heating during transportation. In order to monitor and improve the tree seedling distribution process, the state forest nurseries are taking advantage of a new technology, temperature data loggers. These stainless steel encased computer chips can be programmed to record the temperature at selected time intervals. A programmed data logger can then be placed within a tree order to accurately monitor the temperature throughout the distribution process. This information helps nursery staff identify and correct situations where the seedlings are exceeding acceptable temperature limits and ultimately improves the survival and growth of nursery stock in the field.



Summary of 2004 Program Activities

Jack Pine

- Completed 272 controlled pollinations at Ten Mile Creek second-generation index populations. Focused on trees that did not produce flowers in 2003, as well as selected single pair crosses.
- Harvested 411 cones from the 2003 controlled crosses at Ten Mile second-generation index populations.
- Marked top 66% of individuals at Bean Brook seed orchard to facilitate cone harvesting.
- Removed remnants of first-generation breeding population at Ten Mile Creek to create future planting space.
- Harvested two bushels of cones from Ten Mile Creek for nursery production.
- Collected seed for jack pine demonstration planting.

Eastern White Pine

- Maintained 14-acre family test at the Lake Tomahawk seed orchard and 10-acre family test on the Black River State Forest. The family test represents 256 eastern white pine selections from Wisconsin, Minnesota and the Upper Peninsula of Michigan.
 - Maintenance activities included removal of 2003 bud caps and application of 2004 bud caps. Application of grass herbicide, mowing, tilling, and fencing.
 - Height measurements and survival taken at both sites. Data analyzed to identify family differences.
 - Surveyed damage caused by 2003 summer drought at Black River Falls site. Analyzed data for family differences.
 - Planted border row at Lake Tomahawk site.
- I.D. tags placed on all trees at Sawyer Creek blister rust resistant clonal seed orchard.
- Compiled and analyzed multiple year height and blister rust occurrence data from Sawyer Creek progeny tests.

Red Pine

- Measured DBH and ranked form at Avoca, Ten Mile Creek, and Lake Tomahawk seed orchards.
- Identified and labeled superior trees at each orchard using family plus within-family selection.
- Collected cones from 175 superior trees at the Ten Mile Creek and The Lake Tomahawk seed orchards for use in establishing second generation seed orchards.
- Avoca seed orchard mowed to remove under story growth.
- Harvested cones at Ten Mile Creek using high lifts and measured cost effectiveness.

White Spruce

- Marked the shortest 30% of the population for thinning at the 6-acre Mead Wildlife Area seed orchard based on 1997 height data.
- Removed dense under story vegetation at Lake Tomahawk seed orchard.
- Color coded top 66% of individuals at the Lake Tomahawk seed orchard to facilitate cone harvesting from the best trees.
- Analyzed 2003 height and DBH measurements from Sawyer Creek progeny test.
- Grafted 50 white spruce from 5 best trees in the Sawyer Creek seed orchard based on 2003 measurements.

Red Oak and Black Walnut

- Completed 184 grafts of red oak and black walnut plus tree selections from natural stands in Eau Claire and Grant Counties. These grafts will be kept in containers until large enough to out plant at Bell Center seed orchard.
- Planted 2003 grafts into larger containers.
- Out planted 26 red oak grafts in new clonal orchard site at Bell Center and constructed fences around each to prevent deer damage.
- Mowed Deansville Wildlife Area and Bell Center seed orchards.
- Surveyed trunk damage at Monticello test planting caused by tree shelters.

Miscellaneous

- Hosted a northeast tree improvement conference at Minocqua, Wisconsin.
- Developed paper on the results of the hardwood direct seeding survey.
- Created comprehensive digital database for all seed orchards.